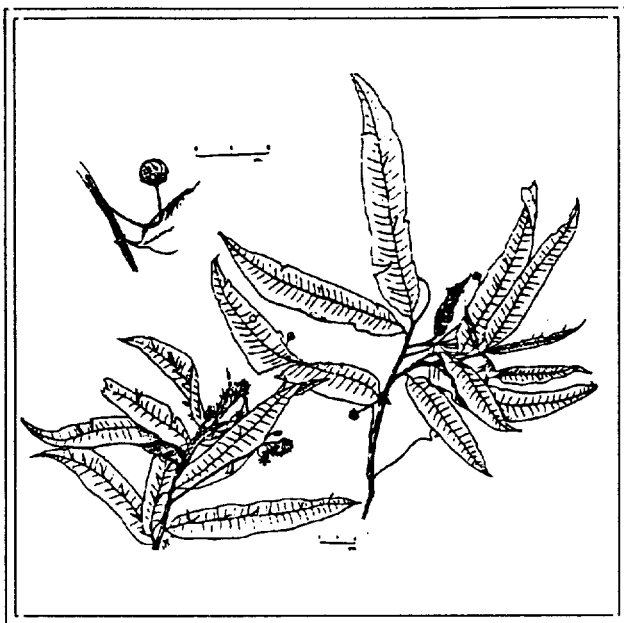


RECOVERY PLAN

SOLANUM DRYMOPHILUM

Enrubi a



U.S. Fish and Wildlife Service




SOLANUM DRYMOPHILUM RECOVERY PLAN

prepared by

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for the
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Approved:



Acting Regional Director, Fish and Wildlife Service

Date: _____ July 9, 1992

Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the Fish and Wildlife Service. They represent the official position of the Fish and Wildlife Service after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citation should read as follows:

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EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR SOLANUM DRYMOPHILUM

Current Status: Solanum drymophilum is listed as endangered. This endemic species is found only in one area of the central mountains of Puerto Rico, the Sierra de Cayey, where from 100 to 150 individuals are known to occur.

Habitat Requirements and Limiting Factors: Solanum drymophilum, a small spiny shrub, is found in evergreen forests of the subtropical wet forest life zone. It occurs on volcanic soils at elevations ranging from 300 to 900 meters. Historically, factors limiting the distribution of the species have been cutting for agriculture, grazing, and the production of charcoal and wood. Today deforestation for urban, rural and industrial expansion encroaches on previously inaccessible areas. The construction of communication facilities on high peaks has resulted in the elimination of forested areas. Due to its spiny nature, it may have been intentionally eradicated by landowners in order to avoid possible injury to cattle.

Recovery Objective: Downlisting

Recovery Criteria: The protection of the existing population and the habitat and the establishment of at least two new self-sustaining populations in protected areas of central Puerto Rico.

Actions Needed:

1. Provide protection for known population on the Tetas de Cayey;
2. Monitor existing population;
3. Conduct research on the life history of the species; evaluate methods of propagation, and locate introduction sites; and,
4. Propagate and produce seedlings for enhancement of existing population and for the establishment of new populations at identified sites.

Date of Recovery: Downlisting should be initiated in 2015, if recovery criteria are met.

Recovery Costs: Recovery costs for Solanum drymophilum have been estimated at \$188,500 for the first 3 years. Subsequent expenditures will depend on the results of these preliminary studies and cannot be estimated at this time.

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PART I. INTRODUCTION

Solanum drymophilum (enrubio) is a small spiny shrub endemic to Puerto Rico. The historical range of the species included the lower montane forests and evergreen seasonal forests in the central and eastern mountain areas; however, today it is restricted to a single locality on the Tetas de Cayey in the Sierra de Cayey. Approximately 100 to 150 individuals occur on this privately-owned land. The species has become endangered as a result of deforestation in these mountains, and apparently as a result of the intentional eradication of the species in order to avoid possible injury to cattle.

Solanum drymophilum was determined to be an endangered species on August 11, 1988, pursuant to the Endangered Species Act of 1973, as amended (U.S. Fish and Wildlife Service 1988). Critical Habitat has not been designated for this species because of the risks of overcollecting or vandalism.

Description

Solanum drymophilum, of the family Solanaceae, was first collected in 1885 by Paul Sintenis in the Sierra de Cayey and later described by O.E. Schulz. The species was later found at several widely dispersed locations in this range of mountains and to the northeast in the Sierra de Naguabo. Mr. R. O. Woodbury found enrubio near Lares in western Puerto Rico in the 1950's (Vivaldi and Woodbury 1981). Solanum drymophilum has apparently been extirpated from all sites except that of the Tetas de Cayey in the Sierra de Cayey.

Solanum drymophilum is a spiny shrub that may reach 18 feet (5.5 meters) in height. The leaves and petioles have minute, white, star-shaped hairs whereas young twigs, inflorescences and flowers have long, whitish star-shaped hairs. Spines, sharp and stiff, yellowish, 5/16 to 7/16 of an inch (.8 to 1.1 centimeters) long, are found primarily along the mid-vein of the leaves and occasionally along the twigs. The leaves, alternate, lanceolate to lanceolate-oblong and entire, are 5 1/2 to 7 1/2 inches (14 to 19 centimeters) long and 5/8 to 1 1/4 inches (1.5 to 3.2 centimeters) wide (Vivaldi and Woodbury 1981).

Inflorescences are lateral, subterminal, many-flowered racemes which may reach 3 to 3 1/2 inches (8 to 9 centimeters) in length. The pedicels are slender and short when in flower but become longer and curved when in fruit. Flowers are perfect with a 5-lobed, bell-shaped calyx. The corolla is 5-lobed, white, folded like a fan, with the lobes united one-third to one-half of their length. The superior ovary is 2-celled and the ovules numerous. The fruit is a glabrous, round, shiny-black berry approximately 3/16 to 5/16 of an inch (5 to 8 centimeters) in diameter. Seeds are numerous, circular,

creamy-yellow in color, and about 1/16 of an inch (1.5 millimeters) in diameter (Vivaldi and Woodbury 1981).

Distribution/Population Status

Solanum drymophilum is known from only one site, the Tetas de Cayey in the Sierra de Cayey in central Puerto Rico, at an elevation of 840 meters (Figure 1). The known site may be described as follows:

1. Las Tetas de Cayey, Salinas municipality, Puerto Rico. From 100 to 150 plants are found in this area, the majority on the more level areas of the southern hill. Plants of all age classes have been observed. Although the population occupies an area of about 5 acres, most individuals are located within a 2-acre area.

The information available indicates that historically the species was found in the southeastern part in the Sierra de Cayey and the Sierra de Naguabo. A population was reported in the 1960's from the Lares area but these individuals can no longer be found.

Reproductive Status

The flowers of Solanum drymophilum are perfect, each flower having both stamen and pistil, and the fruit is a shiny black berry containing numerous small seeds. Little is known about the pollination or dispersal mechanisms for this species.

Field work indicates that the species is in flower and fruiting throughout the year (Vivaldi and Woodbury 1981). In cultivation in Florida peak flowering occurs between October and December. However, under natural conditions it is not known if a peak in flowering occurs at a specific time of the year. Seed production is abundant and plants in all age classes have been observed. This area is utilized for grazing and has been cut back in the past. Resprouting following cutting appears to occur readily.

Habitat Description

Solanum drymophilum is endemic to evergreen forests on volcanic soils at elevations from 1,000 to 3,000 feet (300 to 900 meters). The Cayey area has been described as subtropical wet forest by Ewel and Whitmore (1973). The site where the single population remains is an area of volcanic outcrops known as the Tetas de Cayey.

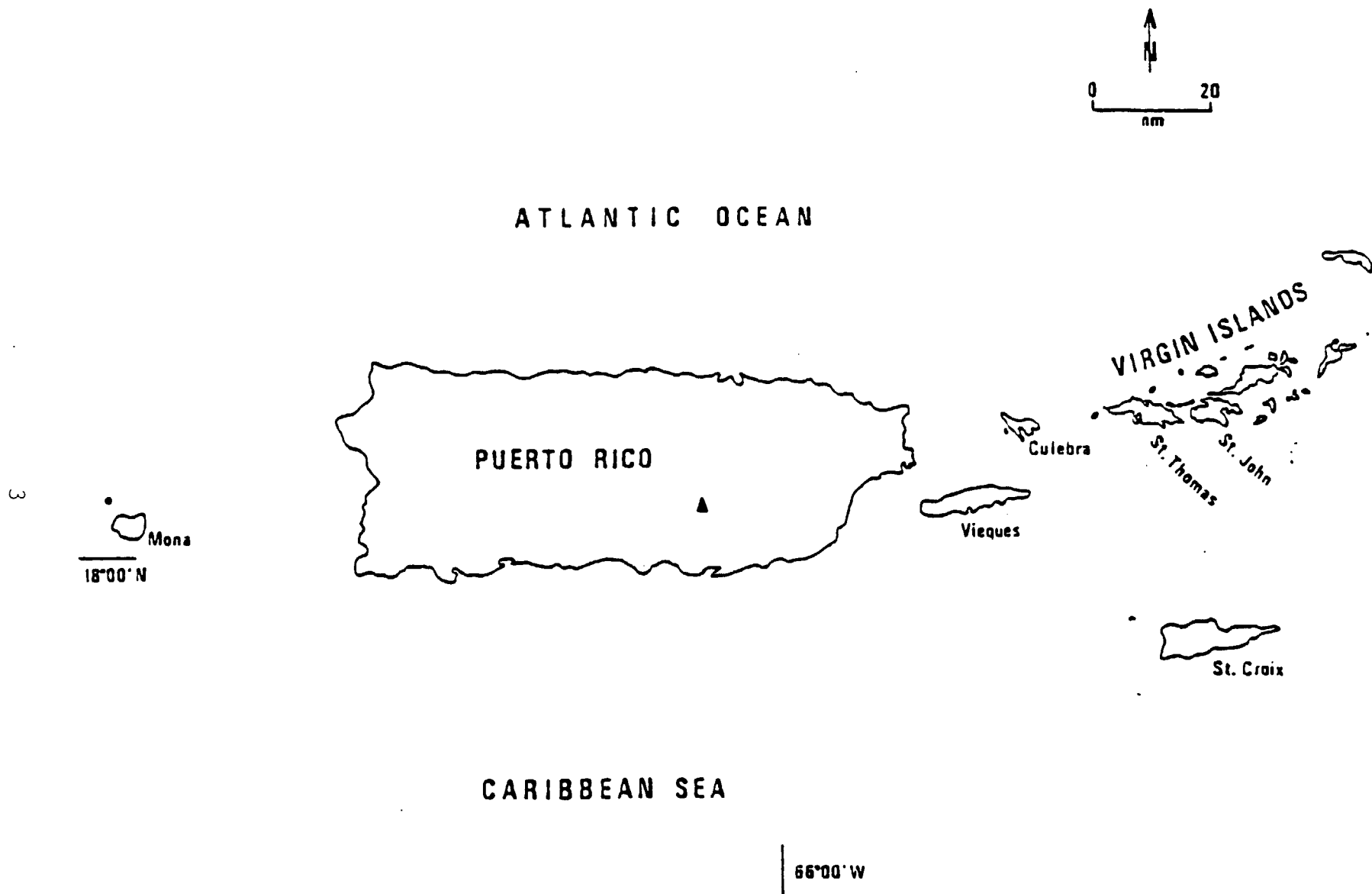


Figure 1. Distribution of Solanum drymophilum. Known populations indicated by (▲).

Mean rainfall at a station near the site, although at a lower elevation, is 92 inches (2029 millimeters). Here, the driest months are January through March and the wet season extends from May to October. Mean annual temperature is 22.7° Celsius with a mean monthly maximum of 24.6° Celsius in July and August and a minimum of 20.4° Celsius in January. The Cayey site, however, is exposed to constant easterly winds and therefore supports a more xeric vegetation than might be expected based on precipitation (Department of Natural Resources 1986).

The Tetas de Cayey site lies in the central mountain region, volcanic in origin. The area is covered by igneous rocks, andesitic in nature. Topography is rough, and is characterized by escarpments, exposed rock on the summits, and is highly dissected by intermittent streams and ravines. Caguabo clay loam soils are found in more level areas and are shallow, well-drained, acid, and moderately permeable. The Caguabo rock outcrop complex is found on the steep side slopes. Rock outcrops cover from 50 to 70 percent of the surface and only very loose, shallow soil material is found between the outcrops.

This Cayey site has been converted to pasture and coffee plantations and therefore little original forest is present. Degraded pasture, composed mostly of Psidium guayava, is typical of the area. The eastern peak is forested, however, the vegetation is much more xeric than might be expected based on rainfall and potential evapotranspiration patterns. The tops of these spectacular cliffs also harbor the candidate species Maytenus ponceana and the endangered tree Banara vanderbiltii.

Reasons for Listing

Among the factors which have historically limited the distribution of Solanum drymophilum include deforestation and selective cutting for agriculture, grazing, production of charcoal, and the cutting of wood in order to provide construction materials. Deforestation for urban and industrial expansion and their associated roads and service facilities are a more recent encroachment on previously inaccessible areas. The construction of communication facilities has resulted in the elimination of forest on higher mountain peaks.

Coffee was extensively planted in these central mountains, and coffee shade trees remain on the Tetas de Cayey site. The area has been and continues to be utilized as pastureland.

Of the four populations documented by the collection of specimens, only one is known to survive. All of these 100 to 150 known individuals occur on privately-owned land, most

within a pasture surrounded by lots being cleared and developed for private homes, as well as one communications facility operated by the Puerto Rico Telephone Company. It is probable that deforestation prior to the creation of pasturelands destroyed many plants at this and other sites in the region. It has been reported that individuals which reestablished the pasturelands then created were eradicated because of their perceived threat to livestock (Vivaldi and Woodbury 1981). Although it appears to readily reseed open areas, total land clearance, as is being practiced in surrounding areas, would eliminate potential sources of seeds.

Conservation Measures

Conservation and recovery measures for Solanum drymophilum are ongoing. Both the Fish and Wildlife Service and the Puerto Rico Department of Natural Resources consider the species when development projects are reviewed for this area. The area has been recommended for acquisition by both the Fish and Wildlife Service and the Department of Natural Resources.

Propagation of enrubio has been carried out by the Fairchild Tropical Garden in Miami, Florida. Plants in cultivation were collected as seed in 1989 from the Cayey site, and some have become 5-foot multibranched shrubs. In cultivation flowering occurs more heavily from October through December. Seed viability is high for fresh seeds and the species roots readily from tip cuttings. In cultivation, the species appears to prefer sandy rather than limestone substrate and shaded conditions (Carol Lippincott, Fairchild Tropical Garden, pers. comm.).

PART II. RECOVERY

A. Recovery Objective

The objective of this recovery plan is to provide direction for reversing the decline of Solanum drymophilum and for restoring this species to a self-sustaining status, thereby permitting it to be reclassified from endangered to threatened or eventually removed from the list.

Solanum drymophilum could be considered for reclassification to a threatened species when (1) the privately-owned population site is given protected status and (2) at least two new self-sustaining populations in Commonwealth Forest units or otherwise protected land have been established. If new populations are discovered, it may be preferable to place greater emphasis on protection, rather than on propagation, in order to achieve a minimum number of plants. The estimated date for recovery is 2015.

B. Outline Narrative

1. Prevent additional habitat loss and decline of known populations.

The known populations and habitat should be protected by both public agencies and private conservation organizations. It is essential as well to maintain a source of material for propagation.

11. Protection of habitat and known individuals.

Protection of habitat of existing populations should be considered a highest priority task for recovery.

111. Protect the privately-owned Tetras de Cayey site.

Because this is the only presently known site, acquisition is the preferred alternative for protection. The area has been proposed for acquisition in the Service Land Acquisition Priority System as well as by the Department of Natural Resource Natural Heritage Program.

112. Monitor all known individuals.

Individual plants should be measured and mapped. Specific plots should be delineated and designated for long-term monitoring.

113. Enforce existing Commonwealth and Federal endangered species regulations.

The Commonwealth Department of Natural Resources' Regulation to Govern the Management of Threatened and Endangered Species of 1985 provides for criminal penalties for illegal take of listed plant species. Development projects which occur in this area are often funded through local agencies or require local permits. The Regulation's Section 10 provides for consultations on endangered species which may be affected by development projects similar to Section 7 of the Endangered Species Act. The 1988 Amendments to the Act prohibit take of plants on privately-owned land when in violation of Commonwealth law or regulations.

2. Collect additional information on the distribution and abundance of *Solanum drymophilum*.

The establishment of recovery priorities and management decisions depends on accurate additional information on distribution and abundance.

21. Continue to search for new populations.

It is possible that undiscovered populations of this species exist in the central mountains. Potential sites should be identified and searched through a cooperative effort by the Service, the Department of Natural Resources, local universities and private organizations. These sites, if located, should be evaluated both as a source of propagative material and with respect to their potential for protection.

3. Research

At present little is known about the population biology of *Solanum drymophilum*. Studies of population biology may be carried out by graduate students, the Puerto Rico Department of Natural Resources, or the Service itself.

31. Assess habitat requirements.

The evaluation of information available from existing studies of the known site and similar sites may assist in obtaining a better definition of habitat requirements of this species.

32. Study reproductive biology and ecology of *Solanum drymophilum*.

Little information is available on the reproductive biology of this species. The management and recovery of enrubio depends on an accurate assessment of these processes.

321. Assess phenology and pollination mechanisms.

The frequency, timing, and abundance of flowering, and the physical and biological factors controlling these processes need to be evaluated. Although the species appears to produce abundant fruit, pollination mechanisms should be considered.

322. Evaluate seed production and dispersal mechanisms.

The quantity of seed produced and its ultimate fate should be assessed. Agents of seed predation and/or seed dispersal should be identified.

323. Evaluate seed viability and germination requirements.
Determine the proportion of viable seed produced and the environmental conditions required for germination. The possibility of allelopathy should be studied as preliminary observations indicate that seeds do not germinate beneath the parent plant.
324. Evaluate requirements for seedling establishment and growth.
Conduct field experiments in conjunction with number 323, in order to determine what conditions are necessary for seedling establishment and survival, critical stages in recruitment.
33. Conduct artificial propagation and utilizing this artificially produced material enhance existing populations or establish new ones.
Utilizing the information obtained from experimental propagation, seedlings should be produced for enhancement of existing populations and the establishment of new ones.
331. Conduct artificial propagation.
The collection of material for artificial propagation may be a cooperative effort between the Service, the Department of Natural Resources, local universities, and local and off-island nurseries. Propagation may be conducted in DNR facilities or at local universities.
332. Select appropriate sites for population introduction or enhancement.
Inventory and select appropriate sites for new or additional plantings of Solanum drymophilum.
333. Assure site protection.
If chosen sites are not protected, steps must be taken to provide protection to the populations established through easement or other mechanisms. Management plans should be developed for these sites, or consideration of the species incorporated into existing management plans (e.g., Commonwealth Forests).

334. Plant seedlings or saplings of Solanum drymophilum.

These should be planted at designated sites as a cooperative effort between concerned agencies. Success must be monitored on a regular basis.

4. Refine recovery goals.

As additional information on the biology, propagation, and management of enrubio is collected, it will be necessary to redefine and modify recovery goals.

41. Determine number of individuals and populations necessary to ensure species' stability.

Environmental and reproductive studies, together with the relative success of population protection measures, will allow more precise and realistic recovery goals to be established.

42. Determine what additional actions, if any, are necessary to achieve recovery goals.

If there are any actions not included in this recovery plan which, during the recovery process become recognized to be species' needs, they must be incorporated into the plan.

C. Literature Cited

- Department of Natural Resources. 1986. Areas conprioridad para la conservación en Puerto Rico. Natural Heritage Program Critical Areas of Puerto Rico. San Juan, Puerto Rico.
- Ewel, J. and J.L. Whitmore. 1973. Ecological life zones of Puerto Rico and the U.S. Virgin Islands. U.S.D.A. Forest Service Research Paper ITF-18. 72 pp.
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- U.S. Fish and Wildlife Service. 1988. Endangered and threatened Wildlife and Plants: Determination of Endangered Status for Solanum drymophilum. Federal Register, Vol. 53, No. 166, August 26, 1988. Pages 32827-32830.
- Vivaldi, J.L. and R.O. Woodbury. 1981. Status report on Solanum drymophilum. Status report submitted to the U.S. Fish and Wildlife Service, Mayagüez, Puerto Rico. 33 pp.

PART III. IMPLEMENTATION SCHEDULE

Priorities in Column 4 of the following Implementation Schedule are assigned as follows:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3: All other recovery actions necessary to provide for full recovery of the species.

IMPLEMENTATION SCHEDULE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates (\$K)			Comments
				FWS Region	Division	Other	FY 1	FY 2	FY 3	
1	111	Protect the privately-owned "Tetas de Cayey" site	2-4	4	FWE	PRDNR			90	Could also be accomplished through conservation easement
1	112	Monitor all known individuals	Ongoing	4	FWE	PRDNR	2	2	2	
1	113	Enforce existing Commonwealth and Federal regulations	Ongoing	4	FWE LE	PRDNR	9	9	9	One DNR ranger half-time
2	21	Continue to search for new populations	2-4	4	FWE	PRDNR Univ.	2	2	2	
2	31	Assess habitat requirements	2-4	4	FWE	PRDNR Univ.	2	2	2	
2	321	Assess phenology and pollination mechanisms	2-4	4	FWE	PRDNR Univ.	12	12	12	12K/yr covers 321, 322, 323, and 324

IMPLEMENTATION SCHEDULE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party		Cost Estimates (\$K)			Comments
				FWS Region	FWS Division	Other	FY 1	FY 2	
		LIST OF ABBREVIATIONS							
		PRDNR - Puerto Rico Department of Natural Resources							
		FWE - Fish and Wildlife Service, Endangered Species Division							
		LE - Fish and Wildlife Service, Law Enforcement							
		Univ. - Universities							
		BotGar - Botanical Gardens							

IMPLEMENTATION SCHEDULE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates (\$K)			Comments
				FWS Region	FWS Division	Other	FY 1	FY 2	FY 3	
2	322	Evaluate seed production and dispersal mechanisms	2-4	4	FWE	PRDNR Univ.				
2	323	Evaluate seed viability and germination requirements	2-4	4	FWE	PRDNR Univ.				
2	324	Evaluate requirements for seedling establishment and growth	2-4	4	FWE	PRDNR Univ.				
1	331	Conduct artificial propagation	Ongoing	4	FWE	PRDNR Univ. BotGar	2	2	2	
1	332	Select appropriate sites for population introduction or enhancement	2-4	4	FWE	PRDNR		1.5		

IMPLEMENTATION SCHEDULE

Priority #	Task #	Task Description	Task Duration (Yrs)	Responsible Party			Cost Estimates (\$K)			Comments
				FWS Region	Division	Other	FY 1	FY 2	FY 3	
1	333	Assure site protection	2-4	4	FWE	PRDNR				
1	334	Plant seedlings or saplings of Solanum drymophilum	Ongoing	4	FWE	PRDNR			4	
2	41	Determine number of individuals and populations necessary to ensure species' stability	Ongoing	4	FWE	PRDNR				
2	42	Determine what additional actions, if any, are necessary to achieve recovery goals	Ongoing	4	FWE	PRDNR				

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